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ABSTRACT

There is evidence in the literature indicating that western education was used not to promote the healthy coexistence of the western and the African cultures but as a sanitizing and civilizing medium. This document describes the need to design science education that adequately meets the needs of the African in such a way that the African view of nature, sociocultural factors, and the logical dialectical reasoning embedded in African metaphysics are taken care of within a changing global community. It is concluded that Science/Technology/Society education would seem to be the medium with the most comprehensive, effective, and adequate attributes for achieving this end result. (PR)

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African Cultural Perspectives and the Teaching of Science

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Introduction

As you would have found in Section 1 of this book, the origin and indeed philosophy and offering of Science Technology and Society (STS) in the different parts of the world have been influenced in the main by several factors some of which are demographic, educational, political, economic, social and cultural.

Section 3, of which this chapter is a part explores public understanding of STS issues from the perspectives of some of the factors listed above. This chapter specifically looks at the non-western, and in particular, African socio-cultural perspectives and their effect on or relationship to the teaching of science. It examines science, technology and society from both the traditional values and western scientific values with a view to illuminating their relationship. Factors, especially the socio-cultural ones, which exert tremendous effect on the teaching and learning of science, as well as some science-related social issues which bear on meaningful exchange and negotiation of ideas in science classrooms are highlighted. A new paradigm for STS education curriculum and instruction has been proposed.

The Global need for STS Education

Whether thought of as a new kind of curriculum material to use for teaching science or a new approach to teaching, Science Technology and Society defined as the teaching and learning of science in the context of total human experiences (Yager, 1991) has to date revolutionised the teaching and learning of science all over the world beyond what the global science curriculum reform of the post-sputnik era had mapped out and expected. It's success is not so much as an attempt to expand the outlet of science but in solving some fundamental problems which the mainstream school science teaching does not and cannot tackle due to a number of constraints. The discussion of these constraints is beyond the scope of this chapter but suffice is to state that they relate to access to science knowledge with a broad base for the greatest majority of learners, contemporary issues, interest of students, materials and presenting the real world to students through an extended and expanded curriculum without hard and fast barriers.

Some of the reasons (Aikenhead, Fleming & Ryan, 1987; Bounkhorst & Yager, 1990; Ziman, 1980; Solomon. 1988; Jegede, 1988) advanced for the teaching of STS can be summarised as follows:

(i) Motivating students to study science and developing interest in science careers beyond the level specified, for compulsory study of the subject. In most countries it is not compulsory to study science beyond the junior secondary school level.
(ii) providing the link between science and the lives of people through the discussion of technological issues which interest the majority of learners.
(iii) redressing the apparent lack of growth in students mastery of process skills in spite of the effort of the science education reforms of the 60's.

(iv) relating the science learned in science classrooms to what goes on in the daily lives of people in relation to real-life experiences of science concepts, world of work, personal interests and curiosity, and some unscientific views held by many in the society.

STS is therefore a megatrend in science education (Yager, 1990) which takes a holistic, problem-solving approach and guides students to think critically across and beyond discipline boundaries about socially relevant science, technology and society issues (Huber, 1988). These characteristics of STS which have become its very strong attributes are probably the reasons why STS has spread to all the corners of the globe emerging as a new focus in science curriculum and instruction and becoming a household name in almost all classrooms in the world.

In addition to the attributes of STS mentioned above, for the developing world especially of the African sub-region, other factors related to the noticeable gaps, imbalances and conflicts that exist between science and technology and the traditional environment tremendously enhanced its easy entrance into science education. As noted by Jegede (1988) some of the most important reasons accounting for the introduction of the STS curriculum in Nigeria (and indeed other African countries) include the following:

1. The general dissatisfaction with the ineffectiveness of the reformed science education curriculum in dealing with the social and other dimensions of science in relation to the immediate environment.
2. The need to address the issue of the place of technology in a developing country.
3. Harnessing the remains of the indigenous technology of say tanning, craft, painting, printing, communication, etc with a view to integrating them with modern technology requires a course like STS to provide a forum that involves the discussion of science and technology far beyond their facts and principles.
4. Certain cultural beliefs and customs that the learner brings into the classroom are in opposition to, or incompatible with, modern science. This leads to misconceptions, negative attitudes towards the study of science and a confused psychological state of mind on the part of the learner.

Introduction of Science into Africa

There is evidence in the literature indicating that western education was used not to promote the healthy coexistence of the western and the African cultures but as a sanitising and civilising medium. As noted by Dart and Pradham (1967), "the attitude and often the intent of western education has been that a 'primitive' or 'decadent' civilisation is to be replaced with a more 'modern' and 'better' one. ...It tends to be particularly strong in science teaching, for science teaching is taken to be the one really unique and powerful offering of the western world" (p.655). With the missionary urge to convert the 'heathen' it has often been assumed that the so-called 'primitive' races of Africa have no science (Maddock, 1981). The fact is that Africa had and still has its own science and technology based on a very different conceptual and cognitive models which were not apparent to, or regarded by, the colonialists who first

introduced western education to Africa. The implications of this have been (a) the super imposition of one culture (western) over another (African) and its science over the indigenous one; (b) the attempt to completely wipe out the science and technology of the indigenous African peoples and hence its culture and history; and (c) the uncomfortable dissonance between the two worlds of science and culture that the learner is torn between in a non-western environment. It is no wonder therefore that teaching science via the reformed science education of the 60's with the limited success achieved in the western societies it originated from was even less successful in a somewhat 'foreign' environment.

Non-Western Cultures

To understand fully and place in context, the problems learners in non-western cultures like in Africa encounter studying western science, it is necessary to briefly discuss what characterise non-western cultures. Again given the focus of this chapter we can only just summarise. Like most traditional non-western cultures, the African society is typically oral with heavy reliance on interpersonal, communication. Learning is a direct communal activity mostly from a sage or elder and it is group or age-grade based. The learner is supposed to be passive and must defer to the supremacy and authority of the elder (who is the teacher). The African society is also characterised by a very strong social heteronomous organisation.

Three fundamental features can be identified from the African belief system especially the religious aspects. First, all Africans believe in the existence of the creator - the supreme God. Second, there is the belief in the continuation of life after death. Reincarnation is a common and very popular aspect of the African culture. Third, the human is seen and regarded as the centre of the universe and that the creator made human beings the focal point (Urevbu, 1987a). This anthropomorphic view of nature by Africans (Ogunniyi, 1988a) governs their thoughts and the way they do things and relate to one another within the community.

Western Science and African Culture

While western science is mechanistic, exact, hypotheses driven, seeks empirical laws, principles and generalisations, and develops theories; the African culture, is 'monistic-vitalistic' (Odhiambo, 1972), metaphysical and based on people. Western science is seen, to some extent, as public property and is divorced from religion, African cosmology is entirely secretive and interpreted as magical and intrinsically interwoven with traditional religion. In the words of Mbiti (1969), "wherever the African is, there is his religion, he carries it to the fields where he is sowing seeds, to the beer parlour.. to a funeral ceremony, to the examination room, if he is a politician to the house of parliament" (p.2).

What this obviously means is that from the stand point of cultural differences emerge different conceptual models of nature reflecting systems based on prototype experiences (Horton, 1971). These two models are the mechanistic and the anthropomorphic, the former based on western scientific world view while the latter is based on the African traditional world view. There is often more than one way to view an issue if one tries hard enough. It is therefore in order and natural for the African to view

nature relative to the indigenous conceptual model. The problem however, occurs when he must learn western science in school at the backdrop of the myriads of socio-cultural factors brought from the traditional environment.

In most African countries, while the study of science is being vigorously pursued as a legitimate and most effective means of national development, technological advancement and scientific literacy, its teaching has remained largely restricted to the giving of information (facts) rather than encouraging critical and creative thinking and personal construction of own knowledge by the learner. In addition, the teaching of science in African classrooms does not emanate from, nor relate to, the socio-cultural environment of the learner. It also does not take account of, or seek to explain daily personal experiences and having interaction with technology in the rapidly growing and changing society. This is where STS is of most worth and use in African classrooms.

Socio-cultural factors

Several people have alluded to the fact that culture has a lot to do with achievement differences in school work (see Jegede and Okebukola, 1988, 1989). Glasser (1991) asserts that cognitive activity in school and outside is inseparable from its cultural milieu. This has also been supported by anthropologists like Ogbu (1992) who says that school learning and performance are influenced by complex social, economic, historical, and cultural factors.

Indeed since every society educates the younger generation as a means of passing down the socio-cultural attributes of its people, the socio-cultural factors within non-western societies become a composite part of the environment and therefore control to a very large extent what a child in such an environment learns and becomes in later life. Since every human "tends to resolve puzzles in terms of the meanings available in a particular socio-cultural environment, the baseline is that the meanings become firmly implanted in the cognitive structure and manifest themselves habitually and may act as templates, anchors or inhibitions to new learning" (Ogunniyi, 1988a).

While efforts have been directed at unravelling other variables that affect science teaching and learning, very little effort is being directed to study the socio-cultural niche of our science classrooms. Studies in this area are needed for two main reasons. The first is global in nature. Culture, as the totality of all humans, does subsume every endeavour (and this includes science education) we undertake. Science education is a cultural and human enterprise involving the transmission of cultural heritage of a people (Maddock 1981; Gallagher and Dawson, 1984). Every investigation of human organisation ought to, therefore, tackle the socio-cultural framework. The second reason stems from my personal experiences as a teacher of students in non-western environment as well as those in western environment with traditional background.

Why is it that students in the categories mentioned above show certain traits which do not seem congruent with what is expected of 'normal' learners in science classes? For example, they hardly want, or display the urge, to ask questions in class; when forced to voice out their opinions some believe

science has very little relationship with their own real world. Others think that the study of science is a weird, special activity requiring some magical and superhuman explanations.

To the science teacher who perhaps shares the same socio-cultural background with this group of students, the issue is real but nonetheless frustrating. It is even worse and may be horrendous for the teacher with a western background who has to teach students of non-western background as members of his class.

Based on our personal experiences as science teachers and teacher educators who have had to grapple with the effect of socio-cultural aspects of the science classroom where an acute dearth of information has been noticed, we embarked on a series of studies in culture and science education.

In sum, the results of our investigations, (Jegede & Fraser 1989; Jegede & Okebukola, 1989, 1990, 1991; Okebukola & Jegede, 1990) have led us to conclude that the following five predictors of socio-cultural influences of the learning and teaching of science in Nigeria are important for science teachers to be aware of.

a) Authoritarianism

This factor characterises the traditional society where the belief is strongly held that the older person, having been exposed to more life experiences, should be in a better position to appraise a situation and pass 'correct' judgement. The society frowns at a situation where the elder's point of view is challenged or questioned. On the basis of this, the elder asserts authority in decision making. It behoves the younger individual to accept without questioning, the directives passed down by the elder. This locus of authority of knowledge gets transferred into the classroom where the science teacher is seen as the elder who 'knows all' in matters relating to scientific facts, processes, principles and laws.

b) Goal Structure

This refers to the interaction pattern among the people of Africa which is predominantly of the co-operative kind. In the co-operative setting, the goal structure of individuals is directed at the same objective and there exists a high interdependence among the goal attainment of the individuals. This contrasts very markedly with the individualistic competitive orientation school science portrays to learners.

c) Traditional Worldview

This relates to traditional beliefs and superstitions being used as framework through which occurrences are interpreted. The society holds the notion that supernatural forces do have significant roles to play in daily occurrences. The younger members of the traditional society are supposed to grow up to learn and believe these without questioning. However, this creates conflict when what the learner of science imbibes in the school is not in agreement with the traditional worldview.

d) Societal Expectation

The success or otherwise of an individual within a community is developed and interpreted through the nature of interaction within a communal society. The behaviour of members in the community is

invariably and intimately linked to, and governed by, that of the larger community. Hence, an individual, particularly a school child always reviews his/her achievement in school as a reflection on his/her home, friends and community.

e) Sacredness of Science

This pertains to conceptual interpretations of science. This is a pervasive view held by a larger proportion of the African society in which the study of science is regarded as something special, requiring magical or weird explanation and incompatible with the thoughts of someone from a non-western society.

There is reason to believe that the currency of some of these factors may transcend international and regional boundaries particularly of Africa, Asia and the Americas (Gallagher and Dawson, 1984; George and Glasgow, 1988). Understanding the socio-cultural framework of a learner's mind is compatible with the emerging paradigm of alternative conceptions and constructivism in science teaching (Driver and Oldham, 1986). This will go a long way in helping to realise the five domains of science education as catalogued by McCormack and Yager (1989).

Science has become an international currency for national and global technological development impacting on other sectors of human endeavour. Contemporary developments indicate that any nation that disregards this does so at her own peril. Indeed the level of science and technology development in a country or region serves as an indicator of the general standard of living. Africa therefore cannot sit on the fence. The efforts that have been made regionally in Africa (eg through the African Primary Science Programme, APSP; and Science Education Project in Africa, SEPA; and within individual countries (eg - the Nigerian Integrated Science Project, NISP, in Nigeria) are positive indications that Africa is prepared to move with the trend.

However, this movement to transform the continent through science and technology has got a number of obstacles to be grappled with. The obstacles arise out of the socio-cultural framework of the African traditional environment. For example, given a situation where (a) there is a conflict of conceptual and instructional models between the school and the traditional society; (b) there is an active interplay of psycho-social and socio-cultural variables in the teaching and learning of science; (c) the science learned at school has very little bearing on what goes on in the lives of individuals in a society that places very centrally human interactivity and communal living; and (d) the science taught and learned at school consists mainly of facts and places heavy reliance on rote memorisation and regurgitation, how can science be invested upon as a viable avenue for development? These problems, although difficult to address, are not insurmountable.

I would like to suggest that based on the international experiences of STS Education over the past two decades, the limited but reasonably successful offerings of STS in some parts of Africa, and the potential it has for the present and future generations and development of Africa, embracing STS therefore

appears to be the most attractive viable option for Africa's educational system. In addition, the objectives of the STS education should include the following:

(a) provide a driving force towards scientific literacy and science for all;
(b) generate information about the African environment to explain natural phenomena
(c) identify and use the fundamental scientific and technological principles, theories, and concepts of the indigenous practices within African society;
(d) arm the populace with vital information and explanations necessary to cope with the ever increasing demands of science and technology;
(e) enable the people to develop to greater heights the indigenous technology, whilst appreciating the science behind it and using it more extensively to solve human problems;
(f) promote greater awareness and encourage the strengthening of the African communal spirit which would, more than ever before, be a central issue as scientific and technological innovations penetrate the fabric of human relationships, potentially leading otherwise to extreme impersonality; and finally
(g) teach and uphold the value of the typical African humane feelings in relation to, and in the practice of technology as a human enterprise.

Some of the reasons accounting for this suggestion are that STS

(i) brings scientists, science educators and indeed all groups of people to think of scientific enterprise as a human enterprise;
(ii) relates what is taught to our day-to-day living;
(iii) is cognitively accessible at different levels to the majority of those who enjoy science studies, want a science based career, or need it for matriculation or certification purposes;
(iv) uses local resources for the understanding of science concepts; and
(v) demonstrate in concrete terms that science and technology are major factors that will impact on the future of the whole world.

Implementation Strategies

Compatible with the objectives of science, technology and society education and especially the achievement of the above five reasons in the African classrooms, three major strategies for restructuring our science education to give it a functional STS flavour are:

(i) using familiar materials and processes.
(ii) teaching and learning science through indigenous technology.
(iii) accommodation and assimilation.

(i) using familiar materials and processes.

If as has been said science and technology are part of human culture; it goes without saying that every society has some science and technology in one form or another. However, the way they are conceived, taught and perhaps used may be different in various cultures. For the African, as an example, the view of nature is quite different from those held elsewhere for reasons already discussed. Teaching western

science (a 'language' about nature 'spoken' through the conceptual understanding of a different culture) in the African society will need to be approached through materials and processes already existing in the traditional environment. Science education and learning must begin from where the child is, even if it means beginning with the examination of the traditional belief system. After all, it has been established that western science and superstition have common grounds (see Malinowski, 1948, Zar'our, 1972). As asserted by Zar'our

> Both superstition and science partially aim at explaining processes and suggesting schemes to predict events, interpret natural phenomena and to solve problems. Both assume implicitly or explicitly the ability of man to understand and to a lesser extent control his environment (p.279).

The identification and exposition of the elements of a number of fundamental scientific principles in some of Africa's so called 'fetish', 'primitive' or 'crude' practices and linking them to some western science principles will certainly help to eradicate the fear or apprehension African children have towards science. Urevbu (1987b) has suggested beginning the teaching of science by focussing on socially relevant issues which hinge of human activities. He cited an example of how Gary and Cole (1967) had to use as their starting point the mathematics used by the people in every day life to teach science in Liberia. Biological, physical and chemical principles relevant to some African beliefs, customs and superstition are excellent ways of bringing home science concepts via familiar materials and processes. A few examples include, the blanching of the popular green leafy vegetable (Amaranthus); drum making and the effect of noise on humans, soap making, palm wine tapping, tie and dye, and the preservation of local food stuffs. An empirical support for the need to use the cultural environment as a vehicle to teach science is found in the study by Jegede and Okebukola (1991), which investigated the relationship between African traditional cosmology and students' acquisition of a science process skill. Science education for African children must begin with and reflect the world-views they already processes focussing on issues which are of relevance, interest and concerns and could motivate their understanding of scientific concepts and processes.

(ii) teaching and learning science through indigenous technology

While it can be said that Africa still lacks sophisticated technological development, there is no question of the existence of a variety of indigenous technology in copious quantity. Indigenous technology abound in arts and crafts, hunting implements, pottery, food production, and irrigation, to mention but a few. The teaching of science through the use of the African version of science and technology and related to local traditions will produce meaningful results. Amara (1987) has found in Sierra Leone that using indigenous technology as a basis for science education encourages more female participation. In a culture where women are made to suffer all forms of deprivation, degradation and humiliation as bye products of the socio-cultural belief systems, Amara's findings will no doubt be a welcome development. Knamiller (1989) also found through a project on linking school science with indigenous science and technology in Malawi that..

> One of the reasons why school science has remained alien to most African children is because we often fail to take into account the science and technology local people are doing, what knowledge and skills they have and what problems they feel are important to consider. (p.2).

Knamiller also found that a common mission in a number of science projects going on in several African countries including Zambia, Ghana, and Malawi, is to aim to package science and technology education material that is meaningful not only for the minority of children who will go on to be scientists, engineers and technicians but also for the general mass of children for whom science and technology has a role to play in their private and civic lives. There are no better practical examples of STS education than the ones Knamiller has cited.

(iii) accommodation and assimilation

It may seem ironic that on one hand the point is being made that the mismatch between science education and the African view of nature might lead to some cognitive conflict and on the other advocating for some form of accommodation and assimilation of the two views of nature. It is a fact of history that the prevailing science and technology in use all over the world originated from the western culture. It is also true that Africa cannot and should not isolate its people from the influence of the products of science and technology. Africans need to understand the theories and generalisations behind some concepts and technological products they use daily. There is a need to resolve the paradox existing in the African traditional societies in which people use technological materials whose science they do not know and the practice of indigenous science and technology which are not recognised as such. Basing his studies on the theories of 'psychic unity of mankind' and 'cognitive restructuring' Ogunniyi (1988b), has shown that some form of 'enlargement' of African traditional world view could be made to accommodate the western scientific point of view. This, he notes, will ameliorate any possible conflicts between the two systems of thought and cites the example of the coexistence of *Shinto* and electronics in modern day Japan. Accordingly, Ogunniyi has proposed the development of a science education curriculum which will not 'supplant or denigrate a traditional culture but to help the people meet modern challenges'.

Urevbu (1987b) also subscribed to the idea that the African child can be helped to achieve or preserve a co-existence that does not violate cultural values in the learning of western science and scientific viewpoints. In proposing that the purpose of education in Africa is not to destroy it's own civilisation in order to replace it with something conceived as 'better', Urevbu cautions that

> an implacable either-or approach, leading to a direct confrontation between African traditional attitudes and a western approach to knowledge, invites conflict both within the students own mind and between students and elders in the community. Such conflict alienates the African child from one world without readily admitting him or her into another (p.291).

Future Directions

In a nutshell what I have tried to bring to the fore in this chapter is the need to design science education that adequately meets with the needs of the African in such a way that the African view of nature, socio-cultural factors, and the logical dialectical reasoning embedded in African metaphysics are taken care of within a changing global community. From what has been discussed in this chapter, STS education would seem to be the medium with the most comprehensive, effective and adequate attributes for achieving this.

Based on my personal experience, my studies and those of other learned African science educators I propose that the way to achieving the desired results is to use what I have labelled as *conceptual eco-cultural paradigm* as mechanism for designing and teaching the science education that would prepare and propel the African continent into the next century. Conceptual eco-cultural paradigm is a state in which the growth and development of an individual's perception of knowledge is made to draw from the socio-cultural environment in which the learner lives and operates. Conceptual eco-cultural paradigm consists of:

(a) generating information about the African environment to explain in natural phenomena;
(b) identification and use of fundamental scientific and technological principles, theories and concepts of indigenous practices within the African society; and
(c) the teaching of the values of the typical African humane feelings in relation to, and in the practice of, technology as a human enterprise.

The concept bears relevance to two major somewhat related educational issues that have emerged recently. The first is the paradigm of constructivism in which the learner constructs own knowledge on the basis of new experiences in terms of an existing conceptual framework. The second relates to the world-view learners in traditional societies take to the science classroom. The learner's world-view acts as a filter through which the mechanistic science concepts taught are assimilated.

The awareness among science educators of the imperative to close the gulf between the learner's socio-cultural environment and school science has begun. Africa needs STS education as a vehicle to reach the desired destination.

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